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Predicting inpatient aggression in forensic services using remote monitoring technology: a qualitative study of staff perspectives

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Abstract

Background: Monitoring risk of imminent aggression in inpatient forensic mental health services could be supported by passive remote monitoring technology, but staff attitudes towards the relevance and likelihood of engagement with this technology are unknown.

Objective: This study aimed to explore staff views, specifically potential benefits and implementation barriers, towards using this technology for monitoring risk of inpatient aggression.

Methods: Five semi-structured focus groups were conducted with 25 nurses in an inpatient forensic mental health service. Thematic analysis with two independent raters was used to identify themes and subthemes related to staff attitudes towards passive remote monitoring. Subsequent member-checking was conducted to ensure the validity of the themes identified by the raters.

Results: Five main themes were identified, one of which concerned the potential benefits that passive remote monitoring could provide for monitoring risk of aggression. Staff suggested it could provide an early warning of impending aggression and enable support to be provided earlier. The remaining themes concerned implementation barriers, including risks to the users' physical and mental wellbeing; data security concerns and potential access by third parties; the negative impact of a constant stream of real-time data on staff workload; and design characteristics and user awareness of the benefits of passive remote monitoring.

Conclusions: Passive remote monitoring technology could support existing methods of monitoring inpatient aggression risk, but multiple barriers to implementation exist. Empirical research is required to investigate whether these potential benefits can be realised, and to identify ways of addressing these barriers to ensure acceptability and user-engagement.

Keywords: mHealth; Remote Monitoring; Aggression; Risk Assessment

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Introduction

Infrequent structured risk assessments for inpatient aggression cannot detect rapid, momentary changes in individual risk factors, limiting their ability to predict imminent aggression. For example, purportedly changeable (dynamic) risk factors have shown non-significant changes over service users' period of treatment [1]. The limited frequency of these assessments may partially explain why they often show low-to-moderate predictive accuracy for aggression [2,3]. Acquiring a continuous, real-time measure of how the severity of risk factors change could provide a more accurate understanding of how these fluctuations relate to the risk of aggressive outcomes [4].

Developments in passive remote monitoring technology (i.e. wearable sensors) mean that factors previously associated with aggression cross-sectionally can now be monitored continuously, in real-time. For example, many devices monitor indicators of autonomic nervous system activity such as electrodermal activity and heart-rate variability, previously associated with aggression in laboratory studies [5–7]. Emerging evidence indicates that passive remote monitoring technology can be used to identify changes in these parameters from one to 30 minutes before the observable act of aggression [8,9], and with greater temporal precision than existing risk assessments alone. Monitoring these parameters in real-time could identify a reliable psychophysiological signature of when aggression may be more likely, enabling support to be offered before this behaviour escalates.

While passive remote monitoring technology has the potential to support current risk assessments for aggression [10–13], to our knowledge the views of frontline staff have not been investigated. There are numerous implementation barriers for novel digital healthcare systems, which often results in low rates of adoption and adherence [14]. For example, staff have reported a potentially beneficial role for smartphone-based support for individuals with psychosis, but also highlighted concerns such as infrastructure requirements, data privacy, and the level of digital literacy and skills required of both service users and staff [15,16]. The views of end-users, including staff, are therefore critical to understanding the desire and need for digital systems to monitor risk of aggression, and the barriers that may be faced.

Inpatient aggression is a barrier to rehabilitation which negatively affects service user and staff wellbeing [17], and passive remote monitoring technology could facilitate appropriate support and de-escalation. However, failing to take a user-centred approach and involve staff in the development and introduction of this technology may mean it is not relevant or acceptable for clinical practice [18]. Therefore, the aim of this study was to explore the attitudes of staff towards passive remote monitoring technology for risk of aggression in inpatient forensic mental health services, with a focus on the potential benefits that this technology could provide and barriers to implementation.

Method

Design

This was an exploratory qualitative study using focus groups following a topic guide. Ethical approval was obtained from the Yorkshire and the Humber-Bradford Leeds Proportionate Review Sub-Committee (18/YH/0221) and King's College London PNM Research Ethics Panel (LRS-17/18-6715).

Participants

Participants were staff in a medium secure forensic mental health service in South London, covering a diverse geographical area including areas of high poverty and urban deprivation. Staff were eligible to participate if their role involved direct contact with service users. Non-clinical staff were not eligible, as the aim of this study was to understand attitudes towards passive remote monitoring technology in a clinical context. Recruitment and analysis were conducted concurrently, and recruitment stopped when data saturation was achieved, the point at which focus groups stopped yielding new themes [19].

Focus Group Topic Guide

The topic guide was based on previous reports [15,16]and included issues related to perceived utility, safety and security, and data connectivity requirements (see Multimedia Appendix 1). This was informed by consultation with two service user/carer advisory groups, a systematic review of the barriers and facilitators to remote monitoring for healthcare [20], and by incorporating suggestions from senior management staff in the recruitment site during the setup phase of this study, to ensure topics relevant to the forensic setting were covered.

Procedure

Ward managers were approached for permission to recruit from their ward, and five groups were conducted in a private room on participants' respective wards during staff handover meetings (two groups) or a time convenient for participants (three groups). Discussions were audio recorded and transcribed verbatim, with personally identifiable content omitted. Participants were provided £10 in cash after the focus groups in recognition of their time. Member-checking focus groups for the primary themes were conducted with the same participants so they could suggest any amendments they felt were appropriate [21]. Participants were informed that the study was part of a larger project, investigating wearable sensors for monitoring risk of aggression through physical signals. To provide context for the discussions, participants were told that the focus groups were the first in a series of studies, which aimed to investigate whether real-time monitoring of psychophysiological signals could assist in the earlier detection of increasing risk of inpatient aggression. Two remote monitoring devices were presented to illustrate the devices. One device (Empatica E4) is worn around the wrist, and the

other (Biovotion Everion) is worn around the upper arm. Although participants were familiar with commercially available wearable devices, the two devices presented were novel to them.

Thematic Analysis

NVivo 12 software [22] facilitated thematic analysis by two independent raters (BG and KN). Both read and reread the transcripts, producing a list of initial codes and then independently collated the codes into a list of candidate themes and subthemes. Both raters' initial identification of individual codes and overall themes were compared, resulting in an initial agreement rate of 59% and 72% for individual codes and overall themes, respectively. Where there were discrepancies (e.g. one rater identifying a code/theme that the other had not), both raters discussed these ratings until a consensus was reached, and themes were revised into their final structure.

Results

Forty-three staff were approached, and 25 took part in the focus groups. Those who declined did so because of the focus group timing (*n* = 9), were required to remain on the ward to maintain minimum staff numbers and carry out clinical duties (n = 4), and five did not specify a reason. Eighteen participants were also available to take part in the member checking focus groups. Participants demographics are presented in Table 1. Five primary themes were identified and are discussed below in addition to subthemes. Figure 1 provides a visual overview of these themes and subthemes.

Theme 1: Utility in Clinical Practice

In every focus group participants identified numerous ways in which using these devices could augment their current practices. One area of discussion related to their capacity for ***prevention and support*** to be offered to users:

> *"Yeah it would be helpful it's like an early-warning sign so, when you know that they are coming to be anxious you find a way of intervening before it escalates."*
>
> [P023, Nurse]

> *"Because sometimes by the time they express it it means it's, it's already you know, so if we can see ahead of time and monitor it, I think it's good."*
>
> [P009, Nurse]

Participants also suggested that these devices could facilitate a ***less-obtrusive monitoring*** approach, enabling assessments without the need for staff to be in physical contact with users:

> *"…Because if a patient is wearing this device even if they are in their bedroom, and they're out of sight of the staff, with the device working you should be able to tell that maybe something has gone wrong… if you just see them physically, they might be in their room they're anxious, they're agitated without you seeing them, you won't be able to tell."*
>
> [P024, Nurse]

Table 1

Participant Demographics

	Focus Group 1 (*n* = 6)	Focus Group 2 (*n* = 6)	Focus group 3 (*n* = 4)	Focus Group 4 (*n* = 5)	Focus Group 5 (*n* = 4)	Total (*N* = 25)	Member Checking Groups (*N* = 18)
Mean age (SD) Range	37.8 (12.4) 22-54	39.5 (11.3) 25-57	37 (10.8) 25-51	55.4 (7.4) 44-64	44.5 (5.1) 41-52	42.7 (11.6) 22-64	44.4 (12.8) 22-64
Gender	Women: *n* = 3 Men: *n* = 3	Women: *n* = 6	Women: *n* = 3 Men: *n* = 1	Women: *n* = 3 Men: *n* = 2	Women: *n* = 1 Men: *n* = 3	Women: *n* = 16 Men: *n* = 9	Women: *n* = 12 Men: *n* = 6
Ethnicity	Black African: *n* = 4 Black Caribbean: *n* = 1 White British: *n* = 1	Black Caribbean: *n* = 3 White British: *n* = 3	Black African: *n* = 4	Black African: *n* = 4 Black Caribbean: *n* = 1	Black African: *n* = 4	Black African: *n* = 16 Black Caribbean: *n* = 5 White British: *n* = 4	Black African: *n* = 15 Black Caribbean: *n* = 1 White British: *n* = 2
Job title	Staff Nurse: *n* = 5 Student Nurse: *n* = 1	Staff Nurse: *n* = 6	Staff Nurse: *n* = 1 Student Nurse: *n* = 2 Ward Manager: *n* = 1	Staff Nurse: *n* = 4 Ward Manager: *n* = 1	Staff Nurse: *n* = 4	Staff Nurse: *n* = 20 Student Nurse: *n* = 3 Ward Manager: *n* = 2	Staff Nurse: *n* = 16 Ward Manager: *n* = 1 Student Nurse: *n* = 1
Highest educational attainment	Higher level qualification (e.g. university degree, professional qualification): *n* = 5 Secondary (A level equivalent): *n* = 1	Higher level qualification (e.g. university degree, professional qualification): *n* = 6	Higher level qualification (e.g. university degree, professional qualification): *n* = 2 Secondary (A level equivalent): *n* = 2	Higher level qualification (e.g. university degree, professional qualification): *n* = 5	Higher level qualification (e.g. university degree, professional qualification): *n* = 4	Higher level qualification (e.g. university degree, professional qualification): *n* = 22 Secondary (A level equivalent): *n* = 3	Higher level qualification (e.g. university degree, professional qualification): *n* = 17 Secondary (A level equivalent): *n* = 1
Mean time in post (SD)	5 years, 5 months (3 years, 5 months)	5 years (4 years, 9 months)	4 years (5 years, 8 months)	10 years, 9 months (4 years, 8 months)	4 years, 7 months (2 years, 1 month)	6 years, 6 months (3 years, 5 months)	6 years, 5 months (4 years, 9 months)

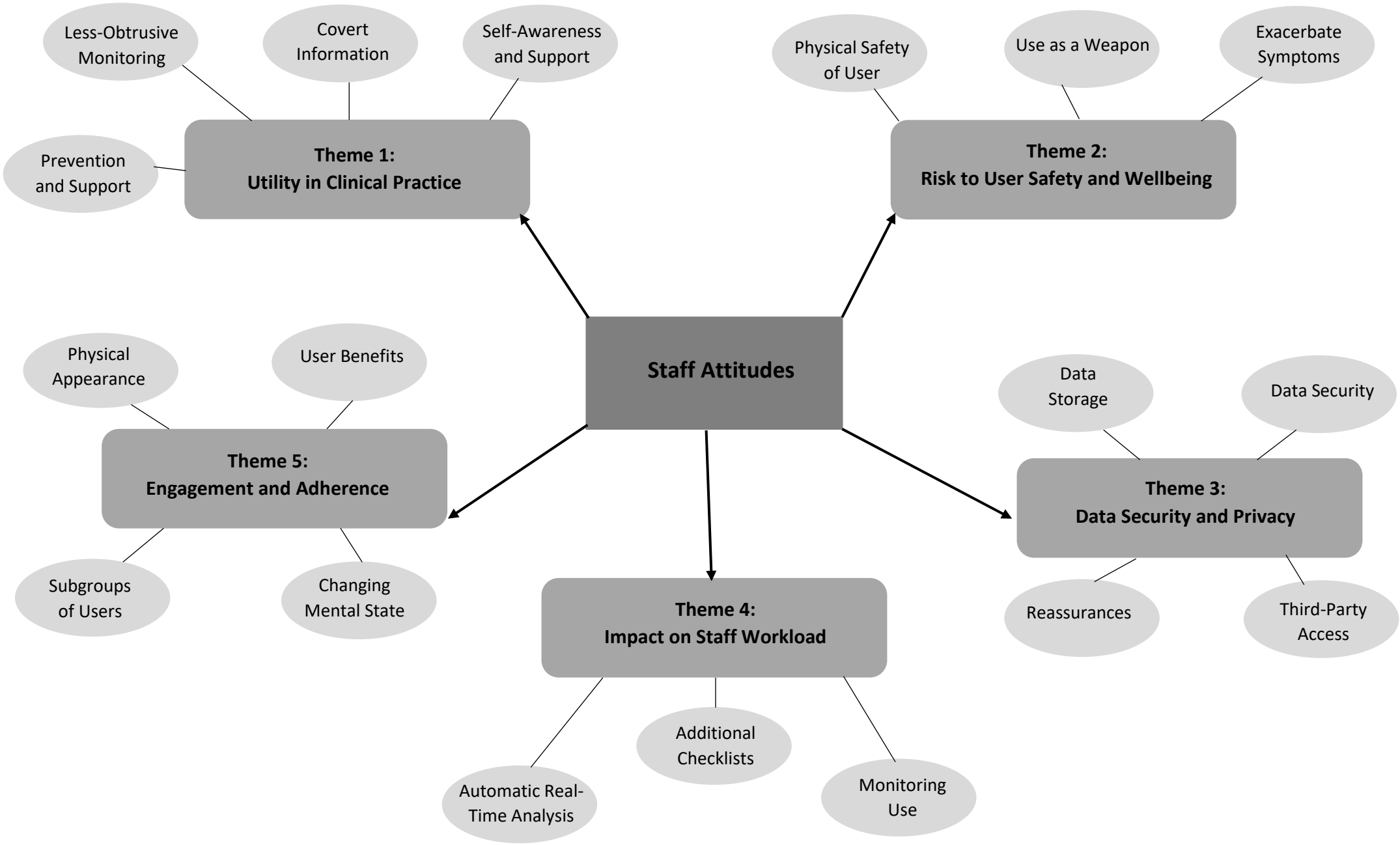

Figure 1 *Themes and sub-themes identified through thematic analysis*

Reflecting on the seemingly unprovoked nature of some aggressive incidents, participants felt that these devices could provide staff with ***covert information*** that may not otherwise be expressed by the users, or observable by staff:

> *"… because we did not see it we think it's unprovoked…but with these devices maybe we will know that there's something happening… before the incident, later maybe attacking somebody or something."*
>
> [P025, Nurse]

> *"…not all our patients will be able to say oh well I feel agitated or be able to come out and say it, but within themselves all the physical you know changes are taking place so I think it's good it will help us to see the covert, you know, things that are not outward that the patients cannot express."*
>
> [P009, Nurse]

As a result of identifying this covert information, participants felt that this could be used to ***foster self-awareness and support*** among users, and augment an anger management programme offered to users:

> *"…we have taught some of them [service users] who did anger management, but some of them are still not withdrawing when they get to the point of…"* [P017, W. Manager]
>
> *"…[to the] point of anger exactly."* [P015, Nurse]
>
> *"…this would be a different way of reminding them, maybe this would be a reminder. Because um, if somebody has done anger management and he knows that by the time he starts breathing heavily, or by the time he feels he's getting um a bit sweaty or agitated and getting wound up… they should disengage. And they have not been doing that because they still don't have the capacity to do that because they don't, um how can I say, they can't get themselves to to take themselves away from aggression. So, what this would do is to then remind them that this is what they need to do, for some of them who have done anger management."*
>
> [P017, Nurse]

Theme 2: Risk to User Safety and Wellbeing

Participants in four focus groups discussed the impact of the devices in relation to the ***physical safety of the user***. One focus group cited the risk of the device being used as a ligature as a concern, due to the elastic armband of one of the devices:

> *"…how far does it stretch can you put it round your neck?"*
>
> [P008, Nurse]
>
> *"Oh yeah, you could I reckon you could stretch it."*
>
> [P011, Nurse]
>
> *"Well that might be an issue you know ligatures."*
>
> [P008, Nurse]

The possibility that the devices could be ***used as a weapon*** was another risk that participants raised, with one focus group again discussing the potential implications of one of the devices having an elastic armband:

"…should be something that they cannot use as a weapon like, there shouldn't be any metal or something that they can use to self-harm."

[P025, Nurse]

"You could use this [referring to device] as a weapon like a slingshot."

[P011, Nurse]

Participants suggested that users' mental wellbeing would need to be considered in addition to their physical safety when wearing the devices. Specifically, participants raised concerns that continuous monitoring could ***exacerbate symptoms*** of paranoia among some users:

"they might think that you are monitoring, that you are controlling their mind controlling their mental state all of this, so it might make more paranoia."

[P003, Nurse]

"…when you give this to a paranoid patient they will think you are monitoring them. It will be so difficult to explain it to them to understand it that this is what you're monitoring…This paranoia could also lead to them not even wearing this."

[P015, Nurse]

Theme 3: Data Security and Privacy

Across three focus groups, participants discussed the measures in place to ensure data collected by the devices is kept secure and confidential. Participants wanted to know in advance specific details concerning ***data storage***, where the information collected by the devices would be stored and who would have access to it; ***data security***, what protections are in place to keep the data private and confidential; and ***access by third parties***, whether data would be shared with other individuals or companies:

"… you know I'm gonna need to know um, what [inaudible] they do, how, even if you say the data is gonna be stored how secure is the storage, can it be hacked, you know cos this is like really private um information…"

[P002, Nurse]

"Yeah I think we'd want reassurance wouldn't we that the information we give is protected confidential and it'd be the same for the patients, know how it's going to be used and. Just make sure it's anonymised the data."

[P008, Nurse]

"you know is it gonna be sold to a third-party like we've seen with social media now where obviously data protection is like a lot…"

[P002, Nurse]

Because of these concerns, participants felt ***reassuring users*** that their data would be kept secure would be necessary, particularly due to the risk of exacerbating symptoms of paranoia discussed in Theme 1:

"Just reassuring them that their data will not go anywhere, it's just for the ward, because some of them will be paranoid."

[P025, Nurse]

One participant made a practical suggestion as to how users could be reassured, drawing parallels with a current ward policy whereby staff model appropriate eating during mealtimes. They suggested that staff members wearing the devices themselves could reassure users:

"… each time they are eating you need to have two staff that will come and model and sit with them… so I'm just thinking that maybe they can try to [inaudible] If they are wearing it that they see staff wearing it as well, they won't be thinking about confidentiality maybe they are trying to take their information or do something else."

[P024, Nurse]

Theme 4: Impact on Staff Workload

While identifying ways in which these devices could be implemented in clinical practice, participants in three focus groups also highlighted that this should not increase staff members' already high workload. Participants stressed the need for ***automatic real-time analysis*** of the data collected by the device, to ensure information can be acted on without additional burden on staff time:

"Yeah I mean that's the only way I can think it'd be useful without that real-time information, we're gonna have to take the watch and then upload the data and see what's going on."

[P002, Nurse]

"Yeah [if] *it's automatic, and we don't have to put in a lot more to get the data and to Analyse the data, then it will be good yeah. But if we have to put in a lot more to measuring And analysing the data and doing deductions for ourselves, that means additional work to do."*

[P009, Nurse]

Participants also questioned whether ***additional checklists*** would accompany the devices, increasing the level of ongoing input required from staff:

"So does this come with a pack or a checklist or something that you've got to fill it out everyday during the monitoring or, will you really only attend to it when you, it gives you any signals or something that there are any changes? How is it done, I'm just thinking if it's something that's supposed to be monitored every now and then and everyday it means additional work isn't it, you feel, more boxes to tick."

[P009, Nurse]

Responsibility for ensuring users are wearing the devices was also discussed, with participants feeling that it would fall to staff to spend additional time ***monitoring use***, therefore taking time away from their other duties:

"Because it's going to be more [inaudible] on staff now. Now they are wearing it they are gonna say oh, gonna spend a couple of minutes encouraging them to put it on or go put it

on, so it's going to take valuable time out of your working day, so, it's going to be time consuming in a way."

[P001, Nurse]

Theme 5: Engagement and Adherence

All focus groups included participant discussion of the numerous factors that may affect the likelihood of users engaging with the devices. The ***physical appearance*** of the device, including overall size and possible resemblance with a tracking device, was one factor:

"And you know this one [referring to device] is so conspicuous it looks so much like a tracking device you know…"

[P009, Nurse]

"…even if they have the reservations about oh we don't want to be monitored and things like that, if they see something that looks a bit stylish they might be more prone to wear it."

[P018, Nurse]

Participants also suggested that users would be more likely to engage with the devices if there was a clear ***benefit to the user***:

"if there's nothing for them they won't take it."

[P017, Nurse]

One benefit that participants felt would appeal to users was whether wearing the devices would positively affect their leave status:

"But then I'm thinking it's one thing how's is it gonna directly benefit them like, what are you gonna tell if I'm a patient, and you wanna give me this I need to know like…is it gonna make my leave better…"

[P002, Nurse]

Four focus groups discussed the impact that ***changing mental state*** would have on users' engagement, suggesting that ***subgroups of users*** may be most likely to engage:

"…that would be a problem getting them to volunteer for it and um making sure they understand completely cos some people are more paranoid on days…than other days so it could be they're fine for five days then the sixth day they're really paranoid"

[P008, Nurse]

"The most settled patients there they will co-operate some of them are, so most of them that are eager to go out they'll co-operate, but this ones like, very paranoid like you said, you will have a tough time."

[P001, Nurse]

Discussion

To our knowledge, this is first study to investigate the attitudes of frontline staff members in inpatient forensic mental health towards passive remote monitoring for risk of aggression. Staff suggested this

technology could benefit their assessments, enabling changes in risk factors that would otherwise not be identified. The real-time stream of information provided by these devices could facilitate targeted support before behaviour escalated into aggression. However, staff also raised numerous implementation barriers, including the physical safety of the user and security of their personal data, negative impact on staff workload, and engagement barriers.

Advantages of Passive Remote Monitoring

Participants suggested the ***covert information*** monitored by these devices may account for the seemingly unprovoked nature of some aggressive incidents. Current risk assessments are rated by staff on the basis of observable characteristics (e.g. irritability and following instructions [23]), therefore passive remote monitoring could provide a more complete clinical picture, consistent with previously hypothesised benefits of digital technology for managing aggression [13]. This additional objective data may also circumvent limitations of structured risk assessments such as rater-bias [24] and incomplete or inaccurate ratings [25].

Participants suggested that the information provided through passive remote monitoring technology could equip them with prior knowledge of when users may be experiencing difficulties, thereby facilitating appropriate ***prevention and support***. Participants discussed this in relation to staff-initiated de-escalation procedures, but also identified an opportunity to ***foster self-awareness and support*** to enable the user themselves to de-escalate. This represents a novel suggestion for the role of passive remote monitoring in managing aggression, with previous literature typically discussing only how this technology could enable staff to manage risk [13]. Passive remote monitoring could therefore enhance users ability to identify manage their unique risk factors for aggression, consistent with national guidelines [26] calls for greater emphasis on individual self-regulation [27]

Enabling users to be monitored without the need for in-person observation was considered ***less obtrusive*** than current observation practices. Enhanced observations (e.g. eyesight and arms-length observations) are experienced negatively by both service users and staff [28], therefore passive remote monitoring may enable monitoring with fewer physical restrictions. This would need to be balanced against the accuracy and range of clinical observations that can be made with passive remote monitoring alone. For example, peer interactions and negative attitudes are relevant risk factors for aggression [29] but cannot be assessed through actigraphy or biosensors alone, highlighting the need for multiple sources of observation data. Over-reliance on technology could also limit the opportunity for physical service user-staff interactions and dialogue, an integral component of therapeutic relationships [30]. As mentioned in one focus group however, providing staff with feedback of changes in psychophysiological parameters of individuals in their care could also facilitate dialogue and staff-

service user interaction (*"I could see that it could be useful, because um it could just be a point of engagement for staff"* P017, Nurse).

The suggestion that passive remote monitoring would only be suitable for ***subgroups of users*** is consistent with a previous evaluation of a passive remote monitoring system (GPS tracker) in a forensic mental health service [31]. The system in this study was primarily used for subgroups at the early stages of their leave period, or during specific periods of transition. Participants felt that these subgroups would be based on users' current mental state and paranoid ideation. Passive remote monitoring may not be suitable for everyone and reflects the need for a personalised approach, which balances the potential benefits to the user (e.g. improved understanding of changes in risk state) and challenges (e.g. difficulties with engagement).

While highlighting potential benefits of passive remote monitoring technology, no participants suggested that technology should replace the current practice of staff-completed risk assessments. This is consistent with previous research reporting universal agreement amongst staff that digital healthcare technologies should be an adjunct to traditional care rather than a replacement, as doing so could be detrimental to user-wellbeing and therapeutic relationships [16]. Future use of passive remote monitoring should therefore be considered as a component of a blended approach which complement, but do not wholly replace, staff-completed structured risk assessments.

The issues discussed above represent hypothesised benefits, and while there is potential for passive remote monitoring technology to support risk management for aggression, this needs to be supported by high-quality empirical evidence. Key issues that need to be addressed include feasibility and acceptability of this technology for end-users, whether a reliable psychophysiological signature for aggression exists, and the accuracy of the data provided by this technology, including the ability to correctly identify changes related to aggression and rule out those that are unrelated.

Implementation Barriers

Participants identified numerous issues which are likely to affect successful implementation of passive remote monitoring systems. The ***physical safety*** concerns raised by participants, relating to ligature risk and ***use as a weapon***, appeared to be linked to a specific design characteristic (elastic armband) of a device presented during the focus groups. This highlights the importance of considering the physical design of passive remote monitoring devices intended for use in inpatient services, where physical safety and risk of self-harm is a management priority. Concerns were raised that continuous passive remote monitoring may ***exacerbate symptoms*** of paranoia, therefore establishing trust with users beforehand is likely to be integral to successful implementation. While previous research of passive remote monitoring in the community indicates acceptability of passive remote monitoring for

individuals with psychosis [32–34], it may be a pertinent issue for those involuntarily admitted to inpatient services and experiencing loss of control and restrictive practices [35].

Consistent with previous research in staff [36,37] and service users [38], participants expressed ***data privacy*** concerns. Rather than a general unspecified concern, participants specified three areas of assurance they would require to be comfortable with passive remote monitoring, relating to ***data storage***, ***security***, and ***accessibility by third parties***. Addressing these concerns in the long-term will require digital health companies to be transparent about the procedures in place for handling user data, and to ensure users have access to this information. In the shorter-term, participants reported that staff could play an important role in providing ***reassurance*** to users. The suggestion that staff could lead by example by trialling the devices themselves reflects the role of staff as positive role models in inpatient services [39], and represents a practical approach to alleviating user concerns.

Participants expressed concern that incorporating passive remote monitoring into their working practice might negatively impact their existing workload. Like Bucci et al. (2019) [16], participants were concerned with the potential burden of handling and analysing large volumes of real-time data, and emphasised that these devices need to be complemented by ***automatic real-time analysis***. While this would address the process of analysing the raw data into an actionable format, it is possible that a constant stream of processed data could still prove overwhelming. It will therefore be important to establish an appropriate format for presenting the data, balancing the frequency of data, level of detail, and staff capacity to act on this information. Participants also highlighted practical considerations such as the introduction of ***additional checklists*** with passive remote monitoring and questioned where responsibility for ***monitoring use*** would lay. Future use of passive remote monitoring devices will therefore need to balance potential clinical benefits with practical implementation issues, to ensure that they support and not hinder clinical care. Machine learning algorithms to process data in real-time and present it in a user-friendly and actionable format would be an option, and participants discussed presenting the data as a visual display in the ward central nursing office. Embedding a dedicated technology specialist within the clinical team could also be considered [40]. While not raised in the focus groups, there are likely to be numerous practical implementation issues to using remote monitoring technology, such as the financial cost of acquiring and maintaining the technology, and any ongoing training requirements for staff.

Achieving the hypothesised benefits of passive remote monitoring devices requires adequate levels of user-engagement. The influence of ***physical appearance*** on engagement highlights the importance of involving users in the choice of devices, as individual preferences may vary. User involvement in the design of these devices could also be an effective way of ensuring they are considered acceptable.

Engaging in passive remote monitoring also needs to have discernible ***benefits to the user***, which in the context of managing risk of aggression could include less restrictive management practices. Communicating these potential benefits could therefore have a positive effect on engagement. User-engagement will also entail staff enthusiasm to work with novel digital technologies. Barriers to organisational change within mental health services include poor job satisfaction among staff, burnout, and lower levels of experience [41,42], and these may also be barriers to the successful introduction of passive remote monitoring technology.

Strengths and Limitations

This study took place in a hospital where passive remote monitoring technology, GPS tracking devices, have been in use for several years to monitor leave [31,43]. Participants' responses may have been influenced by this prior experience and so may not necessarily reflect the views of those unfamiliar with these systems. However, some familiarity might also have facilitated discussion, with the issues and recommendations raised reflecting participants' applied experience of passive remote monitoring. As a medium-secure forensic mental health service, the themes identified in this study may not necessarily generalise to forensic services of higher levels of security (e.g. where more stringent policies for patient access to digital equipment exist), or to non-forensic mental health services where inpatient aggression also occurs.

Senior nursing and managerial staff, who's views may have provided greater organisational context, were present in smaller numbers and so their views were not successfully captured. Including only members of nursing staff may have limited the emergence of new themes. For example, the technical infrastructure requirements for remote monitoring technology could be clarified by seeking the views of support service staff (e.g. technicians and engineers). The time for focus groups was restricted and this might also have limited the emergence of new themes. However, the replication of themes across the different groups makes this unlikely.

Conclusion

Passive remote monitoring technology offers potential benefits to monitoring risk of aggression in inpatient forensic mental health services. However, novel digital systems in mental health have generated substantial hype [44], and these potential benefits have yet to be realised through high quality empirical research. Future research should therefore investigate whether passive remote monitoring is able to achieve the benefits suggested by staff, and reliably identify increased risk of aggression. Specifically, future research should investigate the areas of concern identified by staff in this study to determine acceptability and feasibility of passive remote monitoring, such as whether subgroups based on diagnosis are more likely to engage, and the impact of real-time monitoring on staff workload. Determining whether a reliable psychophysiological signature of imminent aggression

exists is also critical, and robust methods for analysing this data, such as machine learning, will need to be developed and evaluated to do so.

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Conflicts of Interest

The authors have no conflicts of interest to declare.

Multimedia Appendix

Multimedia Appendix 1

Focus Group Topic Guide

- Can you describe what wearable technology is?
  Prompts:
  - *Do you know what can they be used for?*
  - *Can you give any examples of devices you know of/have used?*

- Has wearable technology been used here? If so can you describe its use?

- Could you see any potential barriers to using this kind of technology on the wards?
  Prompts:
  - *Safety (e.g. self-harm, weapon), security, and privacy?*
  - *Data connectivity issues (e.g. transferring the data from device to computer server)?*
  - *Time/practicality (e.g. training in device use, analysing the data)?*
  - *Fitting into current routines/work practices*
  - *Health-related barriers*
  - *Perceived usefulness of this technology*

- Previous researchers have suggested wearables could be used to monitor physical 'warning-signs' of aggression (e.g. heart rate, electrodermal activity). What are your thoughts on this?
  Prompts:
  - *Would this information be useful in your day-to-day work?*
  - *Would you have any concerns about doing this (e.g. privacy)?*
  - *Do you think service users would have concerns about doing this?*

- Is there anything else you think wearables could be used for within your service?
  Prompts:
  - *Do you think they could have any role at all? If not, why?*

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